Review Article

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Epidemiological Characteristics of Traumatic Spinal Cord Injury (TSCI) in the Middle-East and North-Africa (MENA) Region: A Systematic Review and Meta-Analysis

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ABSTRACT

Objective: To systematically search the literature and to summarize current evidence pertaining to the epidemiology of SCI in the MENA region incidence, gender, age, type of the injury and etiology of the injury.
Methods: Embase, PubMed, Scopus, Web of Science and EBSCOhost were systematically searched from their dates of inception till July 2017 for English and non-English language articles. Also, regional databases were searched. Data were extracted from eligible articles and pooled under the random effect model using *R*. References of the included articles were also screened for potentially relevant studies.
Results: We identified 29 articles from seven countries in the MENA region (Turkey, Iran, Saudi Arabia, Egypt, Jordan, Kuwait and Qatar). The mean age of the cases at time of injury was 31.32 (95% CI: 28.74-33.91). The random pooled annual incidence of TSCI per million was 23.24 (95% CI: 5.64-49.21). Pooled proportion of male gender was 77% (95% CI 73-80%) of the cases. Complete paraplegia was the most common type of injury. Thoracic level injury predominated. Also, the most commonly affected age group was 20-29 then 30-39. Motor vehicle accidents were found to be the leading cause of injury, then falls, gunshot, violence and sports. Further meta-regression analysis showed no association between age and etiology of the injury.
Conclusion: This review shows lack of evidence about SCI in most countries of the MENA region. More epidemiological studies are needed.

Keywords: Spinal cord injury; Epidemiology; Incidence; Middle-east; North-Africa; Etiology; SCI.

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Introduction

Spinal cord injury (SCI) is one of the most devastating events in which lesions to the spinal cord cause motor impairments, sensory deficit, or autonomic nervous system dysfunction [1]. The incidence of traumatic spinal cord injury (TSCI) in the developing countries was 25.5/million/year [2]. People with SCI are 2 to 5 times to die prematurely than people without SCI, depending on the health-care system capacity [3]. Moreover, SCI is associated with various economic, psychological and social impacts. For example, in 2008, the total cost of SCI in Australia was estimated to AUS$ 2 billion with life-time cost of AUS$ 5 million per case of paraplegia and AUS$ 9.5 million per case of tetraplegia [4]. With the limited resources in low-income countries, healthcare cost is one of the main barriers affecting the quality of life of people with SCI [5]. Furthermore, clinical symptoms of depression were seen in 20-30% of people with SCI [6]. Because there is no cure for SCI, primary and secondary prevention strategies are vital [7]. Epidemiological evidence will help to plan and implement future preventive measures. Although more than 436 million live in the Middle-East and North-Africa (MENA) region, epidemiological patterns of SCI in the region are not well characterized [8].

This review aims to summarize current evidence pertaining to SCI in the MENA region regarding the incidence, age, gender, etiology and type of injury.

Materials and Methods

Guidelines

We followed the Meta-analysis of observational studies in epidemiology (MOOSE) Statement in reporting this meta-analysis [9].

Search Strategy

One of the authors (Elshahidi) designed and conducted the search process. The search process was performed using a comprehensive list of keywords (list of keywords and details from each database search can be found in the 'supplementary materials: Search Strategy'). No language nor publication period restrictions were applied.

Data Sources

An electronic search on Embase, PubMed, Scopus, Web of Science and EBSCOhost databases was conducted from their dates of inception till July 2017. In addition, other regional databases including the Index Medicus for the Eastern Mediterranean Region (IMEMR) and African Index Medicus were searched. Also, references of included articles were handsearched for relevant records. Also, some previously published systematic reviews were searched for relevant articles.

Criteria for Selecting Studies

Two authors independently screened retrieved records in two steps: title and abstract screening then full-text reviewing. They applied the inclusion and exclusion criteria to select relevant articles (Table 1). Our definition of the Middle-East and North-Africa (MENA) region is based on The World Bank definition (See 'supplementary materials: Search Strategy' for list of the included countries) [10]. Any conflict was resolved by discussion.

Data Extraction

Two authors independently extracted data using a data collection form prepared by the team. The extracted data included: study reference, sample size, country, duration of the study, male/female ratio, incidence, age, type of the study, type of the injury and etiology of the injury. Any disagreement was resolved by discussion.

Data Analysis

SCI epidemiological characteristics were presented as percentages that were pooled with 95% confidence interval (CI) using the 'meta' package, R 3.4.0 [11]. We used Cochran-Q test to identify heterogeneity, and I-square test was used to quantify its extent. When significant heterogeneity was found (p<0.1), the random-effect model was used [12]. A subgroup group analysis by country was applied. Moreover, a meta-regression model was used to assess the association between etiology of injury and male gender and age.

Quality Assessment

A modified version of The Newcastle-Ottawa Scale (NOS) for assessing the quality of non-randomized studies in meta-analyses was used to assess quality of the included studies [13]. Each study could attain a maximum of four points. Studies with ≥3 points were considered of good quality. Those with ≤2 points were considered of poor quality. The scale rated the papers according to: 1) inclusion and exclusion

Table 1. Summary of inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Study	Any study published in any year, language or setting about SCI in the MENA region	Reviews, editorial, basic science studies, animal studies, case studies or studies out of the MENA region
Design	Cross sectional, Retrospective, Prospective	drug trials
Observation	Epidemiological characteristics of spinal cord injury; incidence, age, type of injury, etiology of injury	Specific etiological focus, unrelated specific topics (depression, sleep disorder, pain, pressure ulcer, morbidity or other secondary complications), mixed data without independent report of SCI data, spine injuries.

criteria were clearly stated 2) data came from a secure source (register, administrative database or prospectively collected) 3) detailed reporting of analyses results (95% CI or standard error).

Results

Study Selection

Our comprehensive search retrieved 21 557 references. After abstract and full-text reviewing, 29 articles met our inclusion criteria. The included studies were conducted in seven MENA countries (Figure 1). A summary of the included studies was provided in Tables 2, 3 and 4 [14-42]. The number of cases ranged from 1694 [30] to 4 [35].

Mean Age

The mean age ranged from 41.3 in Turkey [28] to 20.6 in Kuwait [38]. The random pooled estimate of mean age was 31.32 (95% CI: 28.74-33.91) (Figure 2).

Male Gender

27 studies showed high proportion of males than females. The other two studies showed equal proportion of males to females [25, 35]. The random pooled estimate of male proportion across the included studies was 77% (95% CI: 73-80%) (Figure 3).

Incidence

The incidence of SCI ranged from 7.8/million/year in Kuwait [38] to 72.45/million/year in Iran [16]. The pooled estimate of the annual incidence of SCI across studies was 23.24 per million (Figure 4).

Completeness of the Injury

The random pooled estimate for complete paraplegia was 44% (95% CI: 37-53%) (Figure 5). Whereas, complete tetraplegia pooled estimate was 20% (95% CI: 15-27%) (Figure 5).

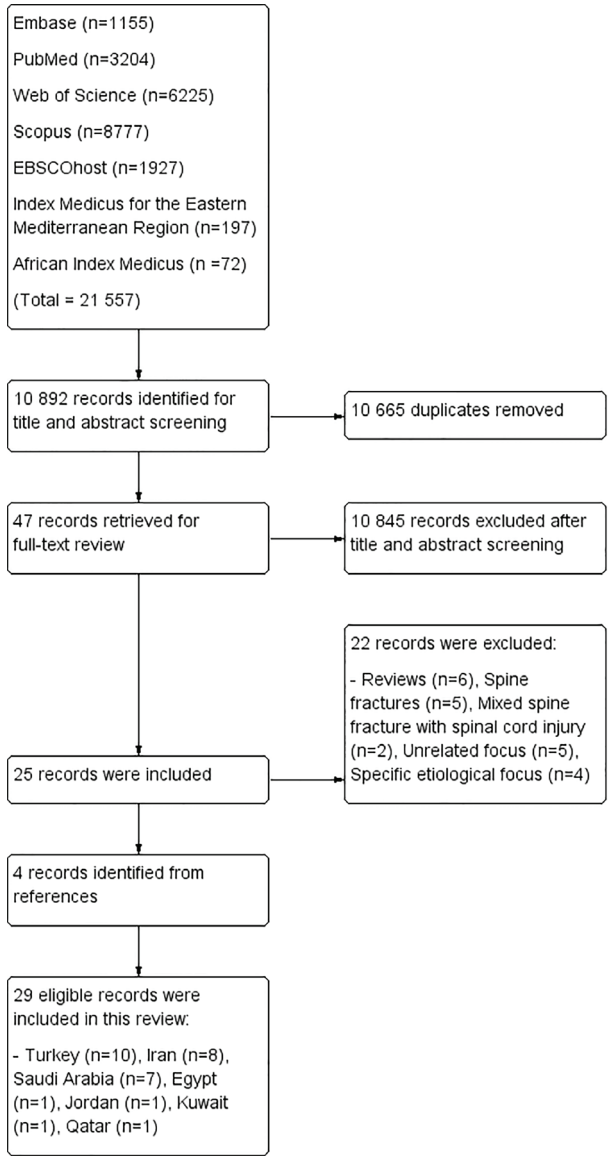

Fig. 1. A flow chart of the search process, performed in July, 2017.

Table 2. Characteristics of the included studies.

Study ID (Reference)	Duration of the study	Country	Sample size	Mean age(SD)	Male (%)	M/F ratio	Incidence (per million)	Prevalence	Type of the study
Al-Jadid *et al*., [14]	January 2005-October 2008	Saudi Arabia	495	34.3 (±0.68)	404 (81.6%)	4.44	-	-	Retrospective review of admission records
Al-Jadid *et al*., [15]	August 1982-November 2010	Saudi Arabia	466	29.75 (±0.73)	398 (85.4%)	5.85	-	-	Retrospective review of hospital records
Rahimi-Movaghar *et al*., [16]	June 2007-June 2008	Iran	496	-	342 (68.95%)	2.22	72.45	4.4 (per 10 000)	Population-based
Al-Habib *et al*., [17]	May 2001-May 2009	Saudi Arabia	23	13.7 (±4.5)	17 (74%)	2.83	-	-	Retrospective study
Tasoglu *et al*., [18]	June 2013- May 2014	Turkey	262	38.3 (± 17.6)	183 (69.8%)	2.32	8–21	-	Retrospective
Derakhshanrad *et al*., [19]	September 2011- March 2015	Iran	1137	29.1 (±11.2)	901 (79.2%)	3.82	-	2.36 (per 10 000)	Cross-sectional study

Gur *et al.*, [20]	1990-1999	Turkey	539	30.62 (± 13.21)	416 (77.17%)	3.38	12.06	-	Retrospective review of hospital records
Erhan *et al.*, [21]	January 1992 - December 2002.	Turkey	106	12.67 (± 4.3)	70 (66%)	1.94	-	-	Retrospective study
Erdoğan *et al.*, [22]	January 2007 - December 2011	Turkey	409	46.82 (±19.05)	253 (61.9%)	1.62	-	-	Descriptive study
Mahmoud *et al.*, [23]	2009 - 2014	Saudi Arabia	418	31.4	244 (78.2%)	3.59	-	-	Retrospective cohort study
Karamehmetoglul *et al.*, [24]	January 1992 - 31 December 1992	Turkey	152	32.5	114 (75%)	3.00	21	-	Retrospective study in all hospitals of Istanbul
Alfrayh *et al.*, [25]	August 1982 - November 1983	Saudi Arabia	260	-	130 (50%)	1.00	-	-	Hospital-based study
El Tallawy *et al.*, [26]	July 2009 - January 2012	Egypt	6	40 (±16)	5 (83.33%)	5.00	-	18 (per 100 000)	Cross-sectional study
Movaghar *et al.*, [27]	January 2003- January 2008	Iran	-	31 (±7)	-	-	-	4.4 (per 10 000)	Cross-sectional study
Atci *et al.*, [28]	2010-2013	Turkey	91	41.3	64 (70.4%)	2.37	-	-	Retrospective review of the emergency department records
Karamehmetoglul *et al.*, [29]	January 1994- December 1994	Turkey	75	31.3	64 (85.33%)	5.82	16.9	-	Retrospective study
Dincer *et al.*, [30]	1974-1985	Turkey	1694	26.8	1282 (75.68%)	3.11	-	-	Retrospective study
Karacan *et al.*, [31]	January 1992 - December 1992	Turkey	581	35.5 (±15.1)	415 (71.42%)	2.50	12.7	-	Retrospective study
Alshahri *et al.*, [32]	January 2003 - December 2008	Saudi Arabia	307	29.5	271 (88%)	7.53	-	-	Retrospective study
Cosar *et al.*, [33]	1996 - 2008	Turkey	127	37.8 (±13.651)	86 (67.7%)	2.10	-	-	Retrospective study
Taghippor *et al.*, [34]	2002-2003	Iran	85	35 (±12)	68 (80%)	4.00	-	-	Prospective hospital based data collection study
Rahimi-Movaghar *et al.*, [35]	September 2007- January 2008	Iran	4	31(±7)	2 (50%)	1.00	44	4.4 (per 10 000)	Population-based survey study
Chabok *et al.*, [36]	2005-2006	Iran	44	38.2	-	-	-	-	Retrospective review of hospital database
Otom *et al.*, [37]	January 1988- December 1993	Jordan	151	30	129 (85.4%)	5.86	18	-	Retrospective chart review
Raibulet *et al.*, [38]	1991-1999	Kuwait	90	20.6	79 (8.7%)	7.18	7.8	-	Retrospective chart review
Alshahri SS *et al.*, [39]	January 2012- December2015	Saudi Arabia	216	28.94	187 (86.5%)	6.45	-	-	Retrospective chart review
Alhoseini *et al.*, [40]	March 2010- July 2011	Iran	138	33.2 (±14.3)	117 (84.8%)	5.57	10.5	-	Retrospective hospital based chart review
Fakharian *et al.*, [41]	1995-1999	Iran	39	39 (±18)	31 (79.4%)	3.88	30	-	Prospective hospital study
Quinones *et al.*, [42]	1987-1996	Qatar	75	32	67 (89.24%)	8.38	12.5	-	Retrospective hospital study

Table 3. Characteristics of the included studies.

Study ID (Reference)	Scale (Franke l/ASIA)	Scale A (%)	Scale B (%)	Scale C (%)	Scale D (%)	Scale E (%)	Complete paraplegia (%)	Complete tetra plegia (%)	Incomplete paraplegia (%)	Incomplete tetraplegia (%)	Cervical	Thoracic	Lumbar/sacral
Al-Jadid *et al.*, [14]	-	-	-	-	-	-	-	-	-	-	-	-	-
Al-Jadid *et al.*, [15]	-	-	-	-	-	-	-	-	-	-	146 (31.33%)	225 (48.28%)	95 (20.4%)
Rahimi-Movaghar *et al.*, [16]	-	-	-	-	-	-	278 (56.04%)	99 (19.9%)	73 (14.71%)	39 (7.86%)	-	-	-
Al-Habib *et al.*, [17]	-	-	-	-	-	-	-	-	-	-	9 (39%)	11 (47.8%)	109 (43.5%)
Tasoglu *et al.*, [18]	ASIA	93 (35.5%)	43 (16%)	56 (21.4%)	69 (26.3%)	1 (0.04%)	76 (29%)	16 (6.1%)	117 (44.7%)	53 (20.2%)	69 (26.3%)	121 (46.2%)	72 (27.5%)
Derakhshanrad *et al.*, [19]	ASIA	608 (53.5%)	203 (18.7%)	200 (17.6%)	109 (9.6%)	7 (0.6%)	496 (43.6%)	115 (10.1)%	308 (27.1%)	218 (19.2%)	358 (31.5%)	658 (57.9%)	121 (10.6%)
Gur *et al.*, [20]	-	-	-	-	-		243(45.08%)	75 (13.91%)	148 (27.48%)	74 (13.72%)	cervical:137 (25.41%), thoracic:198		
Erhan *et al.*, [21]	ASIA	56 (55%)		45 (45%)			-	-	-	-	50 (47.2%)	37 (34.9%)	13 (12.3%)
Erdoğan *et al.*, [22]	ASIA	65 (15.9%)				344 (84.1%)	-	-	-	-			
Mahmoud *et al.*, [23]	ASIA	261 (83.7%)	25 (8.01%)	26 (8.33%)	-		239 (76.6%)	73 (23.4%)	-	-	-	-	-
Karamehmetoglul *et al.*, [24]	-	-	-	-	-	-	102 (67%)	50 (33%)	-	-	50 (33%)	-	102 (67%)
Alfrayh *et al.*, [25]	-	-	-	-	-	-	-	-	-	-	-	-	-
El Tallawy *et al.*, [26]	ASIA	1 (16.7%)	-	1 (16.7%)	4 (66.7%)	-	-	-	-	-	3 (50%)	1 (16.7%)	2 (33.3%)
Movaghar *et al.*, [27]	-	-	-	-	-	-	-	-	-	-	-	-	-
Atci *et al.*, [28]	-	-	-	-	-	-	-	-	-	-	12(13.1%)	56 (61.53%)	23 (25.27%)
Karamehmetoglul *et al.*, [29]	-	-	-	-	-	-	44 (58.7%)	31 (41.3%)	-	-	-	-	-
Dincer *et al.*, [30]	-	-	-	-	-	-	1442 (85.12%)	82 (4.84%)	116 (6.85%)	54 (3.19%)	-	-	-
Karacan *et al.*, [31]	-	-	-	-	-	-	394 (67.8%)	187 (32.18%)	-	-	184 (31.7%)	156 (26.6%)	162 (27.8%)
Alshahri *et al.*, [32]	-	-	-	-	-	-	90 (29%)	66 (22%)	56 (18%)	95 (31%)	-	-	-
Cosar *et al.*, [33]	-	94 (74%)	18 (14.3%)	8 (6.2%)	7 (5.5%)	-	Tetra: 36 (28.3%)		Para: 76 (59.8%)		-	-	-

Taghippor *et al.*, [34]	Frankel	28 (32.94%)	51 (60%)			-	-	-	-	-	-	-	-
Rahimi-Movaghar *et al.*, [35]	-	-	-	-	-	-	-	-	-	-	-	-	-
Chabok *et al.*, [36]	-	-	-	-	-	-	4 (9.1%)	11 (25%)	29 (65.9%)		-	-	-
Otom *et al.*, [37]	Frankel	81 (53.6%)	15 (10%)	34 (22.5%)	21 (13.9%)	-	-	-	-	-	48 (31.8%)	103 (68.2%)	
Raibulet *et al.*, [38]	Frankel	26 (29%)	21 (22.7%)	34 (38.3%)	9 (9.9%)	-	-	-	-	-	-	-	-
Alshahri SS *et al.*, [39]	-	-	-	-	-	-	80 (37.03%)	36 (16.66%)	53 (24.53%)	47 (21.75%)	-	-	-
Alhoseini *et al.*, [40]	ASIA	119 (86.2%)	5 (3.6%)	3 (2.2%)	11 (8%)	-	Tetra: 25 (18.1%)		Para: 113 (81.9%)		-	-	-
Fakharian *et al.*, [41]	-	-	-	-	-	-	-	-	-	-	-	-	-
Quinones *et al.*, [42]	-	-	-	-	-	-	21 (28%)	23 (30.7%)	11 (14.7%)	20 (26.6%)	43 (57.3%)	32 (42.66%)	

Table 3. Characteristics of the included studies.

Study ID (Reference)	Scale (Frankel/ASIA)	Scale A (%)	Scale B (%)	Scale C (%)	Scale D (%)	Scale E (%)	Complete paraplegia (%)	Complete tetra plegia (%)	Incomplete paraplegia (%)	Incomplete tetraplegia (%)	Cervical	Thoracic	Lumbar/sacral
Al-Jadid *et al.*, [14]	-	-	-	-	-	-	-	-	-	-	-	-	-
Al-Jadid *et al.*, [15]	-	-	-	-	-	-	-	-	-	-	146 (31.33%)	225 (48.28%)	95 (20.4%)
Rahimi-Movaghar *et al.*, [16]	-	-	-	-	-	-	278 (56.04%)	99 (19.9%)	73 (14.71%)	39 (7.86%)	-	-	-
Al-Habib *et al.*, [17]	-	-	-	-	-	-	-	-	-	-	9 (39%)	11 (47.8%)	109 (43.5%)
Tasoglu *et al.*, [18]	ASIA	93 (35.5%)	43 (16%)	56 (21.4%)	69 (26.3%)	1 (0.04%)	76 (29%)	16 (6.1%)	117 (44.7%)	53 (20.2%)	69 (26.3%)	121 (46.2%)	72 (27.5%)
Derakhshanrad *et al.*, [19]	ASIA	608 (53.5%)	203 (18.7%)	200 (17.6%)	109 (9.6%)	7 (0.6%)	496 (43.6%)	115 (10.1)%	308 (27.1%)	218 (19.2%)	358 (31.5%)	658 (57.9%)	121 (10.6%)
Gur *et al.*, [20]	-	-	-	-	-		243(45.08%)	75 (13.91%)	148 (27.48%)	74 (13.72%)	cervical:137 (25.41%), thoracic:198		
Erhan *et al.*, [21]	ASIA	56 (55%)		45 (45%)			-	-	-	-	50 (47.2%)	37 (34.9%)	13 (12.3%)

Erdoğan *et al.*, [22]	ASIA	65 (15.9%)				344 (84.1%)	-	-	-	-			
Mahmoud *et al.*, [23]	ASIA	261 (83.7%)	25 (8.01%)	26 (8.33%)	-		239 (76.6%)	73 (23.4%)	-	-	-	-	-
Karamehmetoglul *et al.*, [24]	-	-	-	-	-	-	102 (67%)	50 (33%)	-	-	50 (33%)	-	102 (67%)
Alfrayh *et al.*, [25]	-	-	-	-	-	-	-	-	-	-	-	-	-
El Tallawy *et al.*, [26]	ASIA	1 (16.7%)	-	1 (16.7%)	4 (66.7%)	-	-	-	-	-	3 (50%)	1 (16.7%)	2 (33.3%)
Movaghar *et al.*, [27]	-	-	-	-	-	-	-	-	-	-	-	-	-
Atci *et al.*, [28]	-	-	-	-	-	-	-	-	-	-	12 (13.1%)	56 (61.53%)	23 (25.27%)
Karamehmetoglul *et al.*, [29]	-	-	-	-	-	-	44 (58.7%)	31 (41.3%)	-	-	-	-	-
Dincer *et al.*, [30]	-	-	-	-	-	-	1442 (85.12%)	82 (4.84%)	116 (6.85%)	54 (3.19%)	-	-	-
Karacan *et al.*, [31]	-	-	-	-	-	-	394 (67.8%)	187 (32.18%)	-	-	184 (31.7%)	156 (26.6%)	162 (27.8%)
Alshahri *et al.*, [32]	-	-	-	-	-	-	90 (29%)	66 (22%)	56 (18%)	95 (31%)	-	-	-
Cosar *et al.*, [33]	-	94 (74%)	18 (14.3%)	8 (6.2%)	7 (5.5%)	-	Tetra: 36 (28.3%)		Para: 76 (59.8%)		-	-	-
Taghippor *et al.*, [34]	Frankel	28 (32.94%)	51 (60%)			-	-	-	-	-	-	-	-
Rahimi-Movaghar *et al.*, [35]	-	-	-	-	-	-	-	-	-	-	-	-	-
Chabok *et al.*, [36]	-	-	-	-	-	-	4 (9.1%)	11 (25%)	29 (65.9%)		-	-	-
Otom *et al.*, [37]	Frankel	81 (53.6%)	15 (10%)	34 (22.5%)	21 (13.9%)	-	-	-	-	-	48 (31.8%)	103 (68.2%)	
Raibulet *et al.*, [38]	Frankel	26 (29%)	21 (22.7%)	34 (38.3%)	9 (9.9%)	-	-	-	-	-	-	-	-
Alshahri SS *et al.*, [39]	-	-	-	-	-	-	80 (37.03%)	36 (16.66%)	53 (24.53%)	47 (21.75%)	-	-	-
Alhoseini *et al.*, [40]	ASIA	119 (86.2%)	5 (3.6%)	3 (2.2%)	11 (8%)	-	Tetra: 25 (18.1%)		Para: 113 (81.9%)		-	-	-
Fakharian *et al.*, [41]	-	-	-	-	-	-	-	-	-	-	-	-	-
Quinones *et al.*, [42]	-	-	-	-	-	-	21 (28%)	23 (30.7%)	11 (14.7%)	20 (26.6%)	43 (57.3%)	32 (42.66%)	

Table 4. Characteristics of the included studies.

Study ID (Reference)	Motor accident	Falls	Gunshot	Sport-related	Violence	Others	0-9	10 to 19	20-29	30-39	40-49	50-59	60-69	≥70
Al-Jadid *et al*., [14]	-	-	-	-	-		-	55 (11.11%)	198 (40%)	98 (19.8%)	60 (12.12%)	31 (6.26%)	42 (8.5%)	11 (2.22%)
Al-Jadid *et al*., [15]	377 (80.9%)	51 (10.94%)	30 (6.45)	3 (0.64%)	5 (1.07%)		0-15: 32 (6.9%), 16-30: 270 (58%), 31-45:100 (21.4%), ≥45: 64 (13.7%)							
Rahimi-Movaghar *et al*., [16]	-	-	-	-	-	-	3 (0.6%)	33 (6.65%)	133 (26.81%)	118 (23.79%)	104 (20.96%)	≥50: 105 (21.17%)		
Al-Habib *et al*., [17]	13 (56.5%)	8 (35%)	2 (8.6%)	-	-		-	-	-	-	-	-	-	-
Tasoglu *et al*., [18]	79 (30.2%)	90 (34.4%)	17 (6.46%)	5 (1.9%)	20 (7.6%)	51 (19.44%)	0-15: 17 (6%), 16-30: 86 (32.5%), 31-45:68 (25.9%), 46-60: 56 (21%), 61-75: 32 (13.1%). ≥76: 4 (1.5%)							
Derakhshanrad *et al*., [19]	703 (61.8)%	279 (24.5%)	-	32 (2.8%)	43 (3.8%)	80 (7.1%)	-	76 (6.7%)	646 (56.8%	316 (27.8%)	86 (7.6%)	13 (1.1%)	-	-
Gur *et al*., [20]	200 (37.1%)	172 (32%)	115 (21.33%)	-	11 (2.04%)	41 (7.6%)	0-14:32 (5.9%), 15-29:261 (48.42%), 30-44:158 (29.3%),45-59:64 (11.87%),≥60:24 (4.45%)							
Erhan *et al*., [21]	43 (40.6%)	36 (34%)	10 (9.4%)	11 (10.4%)	-	6 (5.7%)	-	-	-	-	-	-	-	-
Erdoğan *et al*., [22]	68 (16.6%)	292 (71.4%)	-	14 (3.4%)	-	35 (8.6%)	-	-	-	-	-	-	-	-
Mahmoud *et al*., [23]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Karamehmetoglul *et al*., [24]	62 (41%)	65 (43%)	8 (5%)	-	3 (2%)	11 (7%)	4 (2.63%)	16 (10.5%)	54 (35.5%)	35 (23.02%)	20 (13.15%)	12 (7.89%)	8 (5.26%)	3 (1.97%)
Alfrayh *et al*., [25]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
El Tallawy *et al*., [26]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Movaghar *et al*., [27]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atci *et al*., [28]	34 (37.36%)	54 (59.3%)	-	2 (2.2%)	1 (1.1%)	-	-	6 (6.6%)	18 (19.8%)	21 (23.08%)	23 (25.27%)	12 (13.19%)	4 (4.4%)	7 (7.7%)
Karamehmetoglul *et al*., [29]	19 (25.3%)	28 (37.3%)	22 (29.3%)	-	1 (1.3%)	-	2 (2.6%)	5 (6.7%)	29 (38.7%)	17 (22.7%)	15 (20%)	5 (6.7%)	2 (2.7%)	-
Dincer *et al*., [30]	600 (35.41%)	500 (29.51%)	372 (21.95%)	-	34 (2%)	188 (11.1%)	58 (3.42%)	394 (23.26%)	548 (32.35%)	360 (21.25%)	196 (11.57%)	110 (6.49%)	28 (1.65%)	-
Karacan *et al*., [31]	286 (48.8%)	212 (36.5%)	11 (1.9%)	7 (1.2%)	19 (3.3%)	-	9 (1.5%)	57 (9.8%)	180 (30.9%)	127 (21.9%)	87 (15%)	67 (11.8%)	40 (6.9%)	10 (1.8%)
Alshahri *et al*., [32]	262 (85%)	28 (9%)	14 (5%)	3 (1%)	-	-	(14–15 =8 (3%)), (16–30=196 (64%)),(31–45=72 (23%)),(46–60=23 (7%)) ,(61–75=8 (3%))							
Cosar *et al*., [33]	70 (55.1%)	43 (33.9%)	10 (7.9%)	4 (3%)	-	-	-	-	-	-	-	-	-	-
Taghippor *et al*., [34]	34 (40%)	32 (37.64%)	-	-	2 (2.35%)	1 (1.17%)	2 (2.35%)	10 (11.76%)	31 (36.47%)	18 (21.17%)	8 (8.4%)	11 (12.94%)	60+: 5 (5.8%)	
Rahimi-Movaghar *et al*., [35]	3 (75%)	1 (25%)	-	-	-	-	-	-	-	-	-	-	-	-
Chabok *et al*., [36]	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Otom *et al.*, [37]	67 (44.4%)	32 (21.2%)	39 (25.8%)	4 (2.6%)	3 (2%)	6 (4%)	0-19: 37 (24.5%)	54 (35.8%)	24 (15.9%) More than 40: 36 (23.8%)
Raibulet *et al.*, [38]	57 (63.3%)	22 (24.7%)	-	-	2 (2.2%)	8 (8.9%)	-	-	- - - -
Alshahri SS *et al.*, [39]	196 (90.8%)	7 (3.2%)	-	-	13 (6%)	-	-	-	14-25:118 (55%), 26-35:53 (24.5%), 36-45:16 (7.4%), 46-55:16 (7.4%), 56-65:8 (3.7%), 66+:5 (2.3%)
Alhoseini *et al.*, [40]	56 (40.57%)	63 (45.65%)	-	-	-	19 (1376%)	-	-	- - - -
Fakharian *et al.*, [41]	-	-	-	-	-	-	Less 20: 3 (7.7%), 20-50: 27 (69.2%), more 50: 9 (23.07%)		
Quinones *et al.*, [42]	54 (72%)	10 (13.3%)	-	-	-	11 (14.7%)	-	-	- - - -

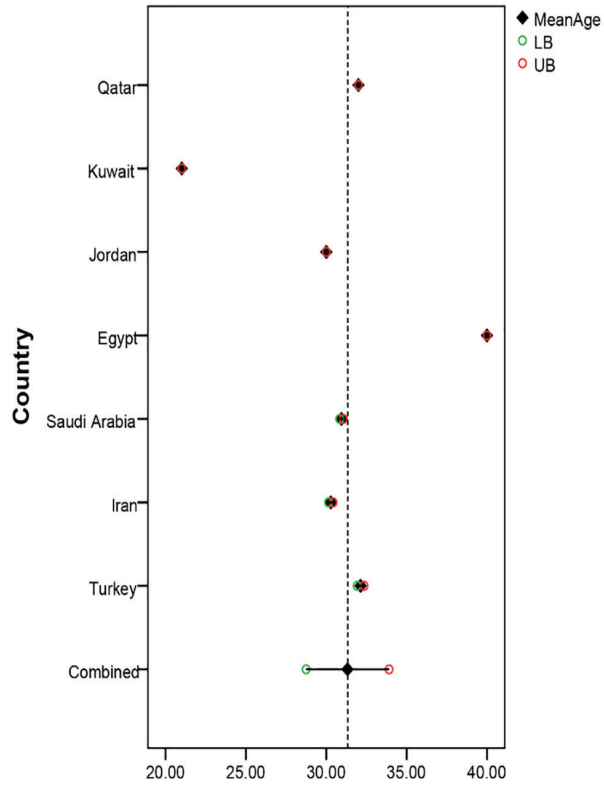

Fig. 2. Random pooled mean age

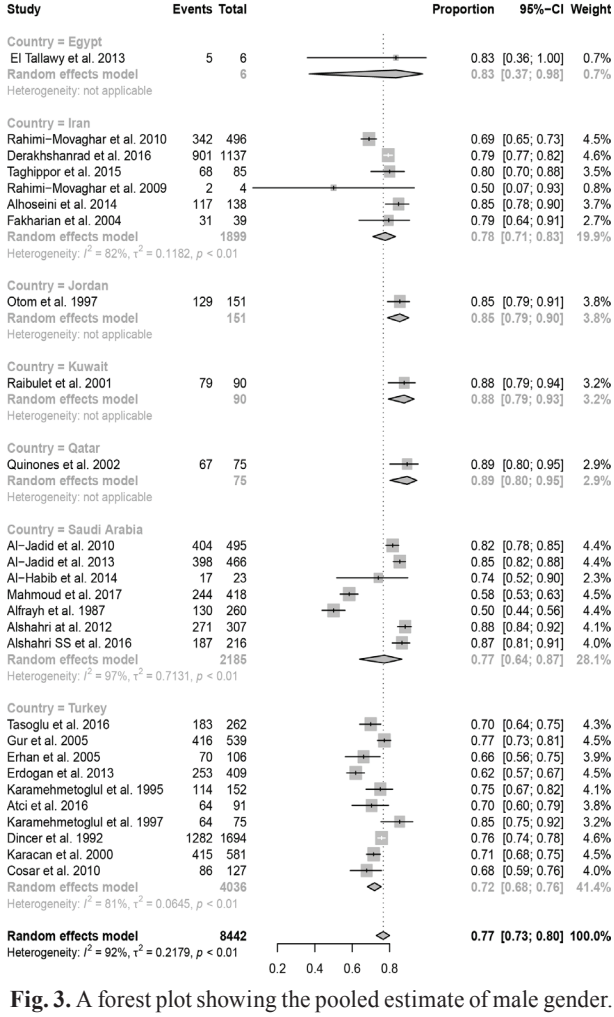

Fig. 3. A forest plot showing the pooled estimate of male gender.

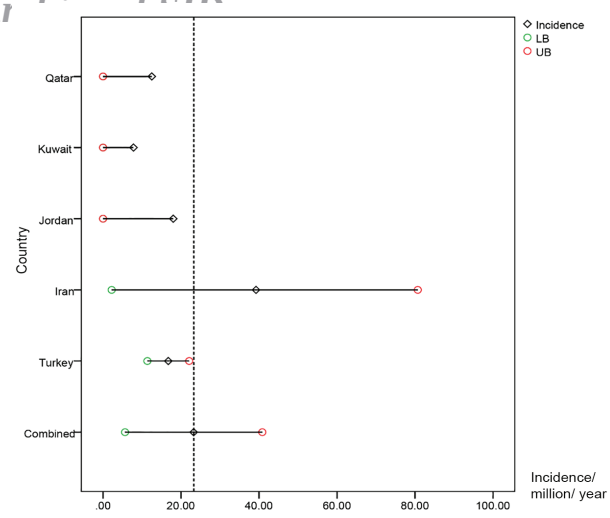

Fig. 4. A forest plot showing the pooled estimate of the SCI incidence/million/year

Incompleteness of the Injury

Incomplete paraplegia injury showed a random pooled estimate of 20% (95% CI: 13-30%) (Figure 5). And, incomplete tetraplegia injury has a random pooled estimate of 15% (95% CI: 9-24%) (Figure 5).

Level of the Injury

Injury at the cervical level was found to have a random pooled estimate of 31% (95% CI: 27-36%) (Figure 6) whereas, the random pooled estimate for thoracic-level injury was 42% (95% CI: 32-53%) (Figure 6) and, the random pooled estimate for lumbar/sacral level injury was 29% (95% CI: 19-42%) (Figure 6).

Etiology of the Injury

The random pooled estimates for motor vehicle accidents (MVA), falls, gunshots, sports and violence

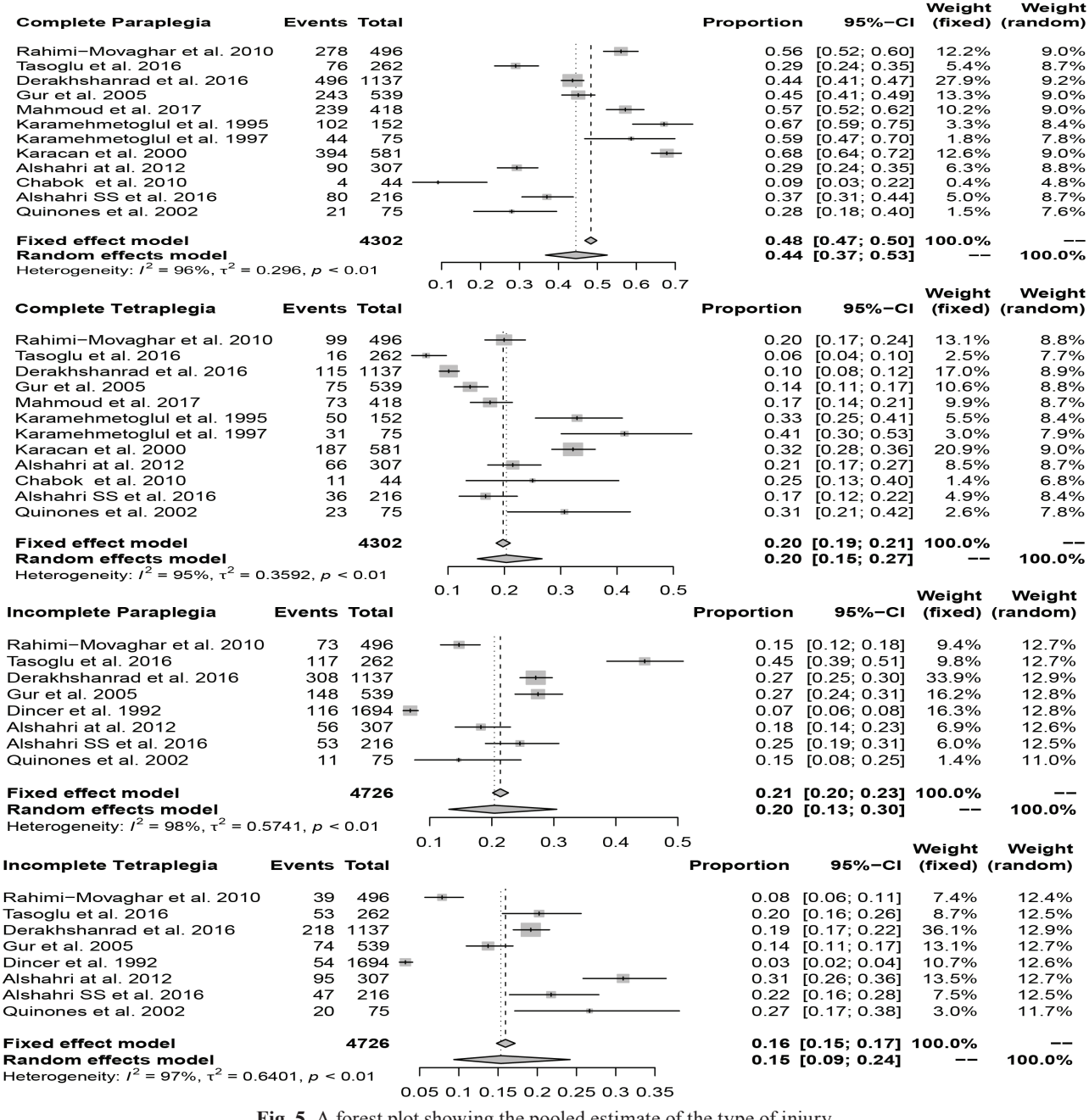

Fig. 5. A forest plot showing the pooled estimate of the type of injury

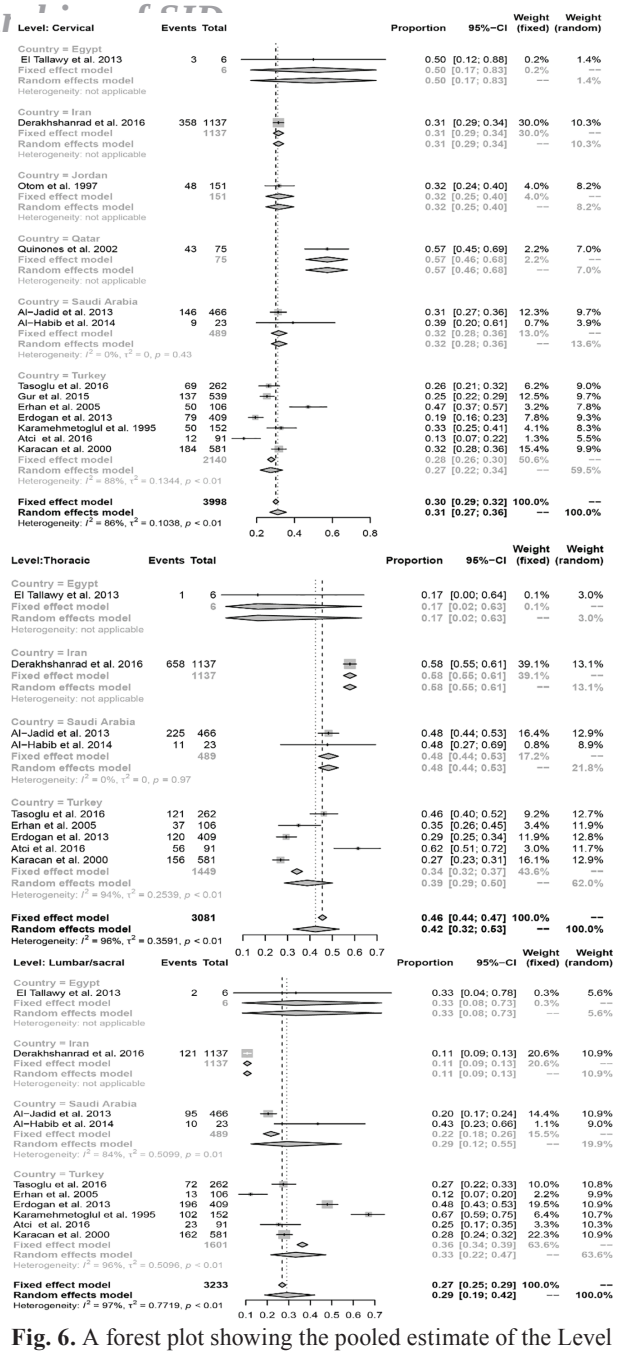

Fig. 6. A forest plot showing the pooled estimate of the Level of the injury

were found to be 51% (95% CI: 42-60%), 29% (95% CI: 23-36%), 10% (95% CI: 6-15%), 2% (95% CI: 1-4%) and 3% (95% CI: 2-4%) respectively (Figure 7). In addition, the pooled estimate for etiology by country showed that MVA were the leading cause of injury and then falls, except in Turkey were falls were the leading etiology (Figure 8). Moreover, based on a meta-regression model to investigate possible association between male gender and mean age, male gender was found to have no association with any cause of the injury. However, mean age was found to have association between MVA (p<0.0004), falls (p<0.0001) and sports (p<0.041).

Age Groups

The random pooled estimates for the age groups

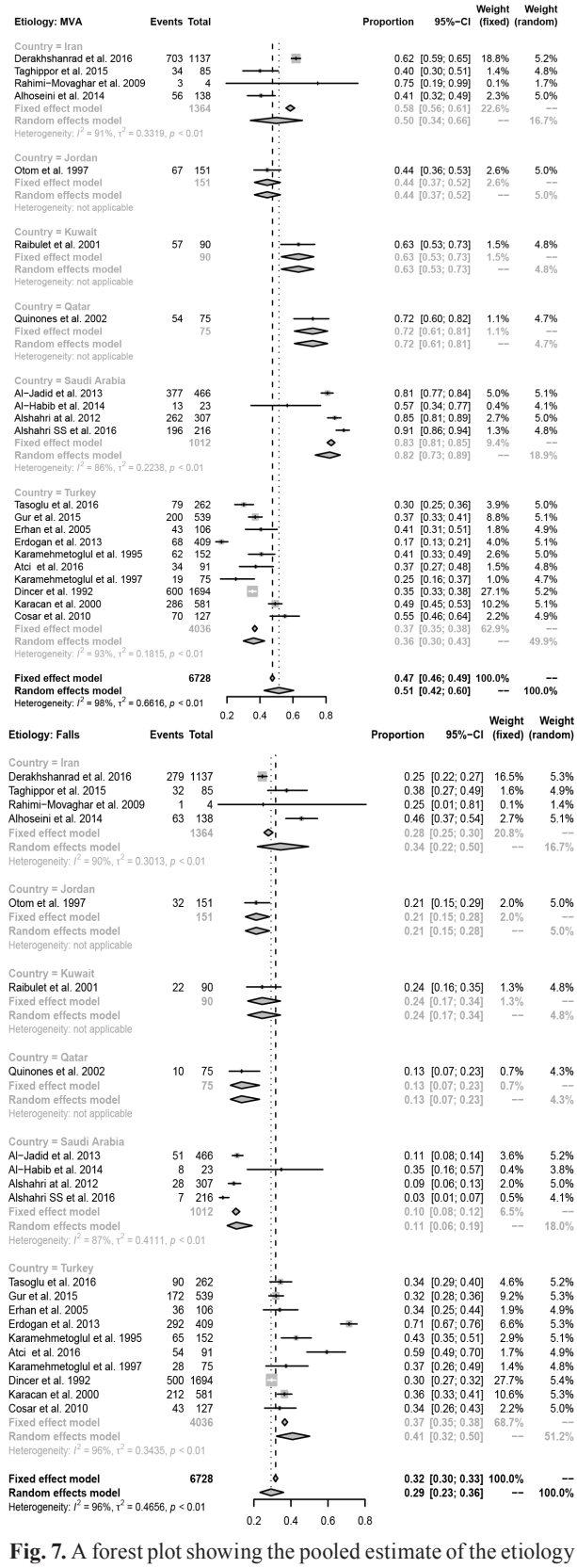

Fig. 7. A forest plot showing the pooled estimate of the etiology of injury

0-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69 and ≥70 were found to be 2% (95% CI: 1-4%), 10% (95% CI: 6-15%), 35% (95% CI: 28-43%), 22% (95% CI: 20-25%), 14% (95% CI: 11-18%), 7% (95% CI: 4-11%), 4% (95% CI: 2-8%) and 3 % (95% CI: 1-5%) respectively (Figure 9).

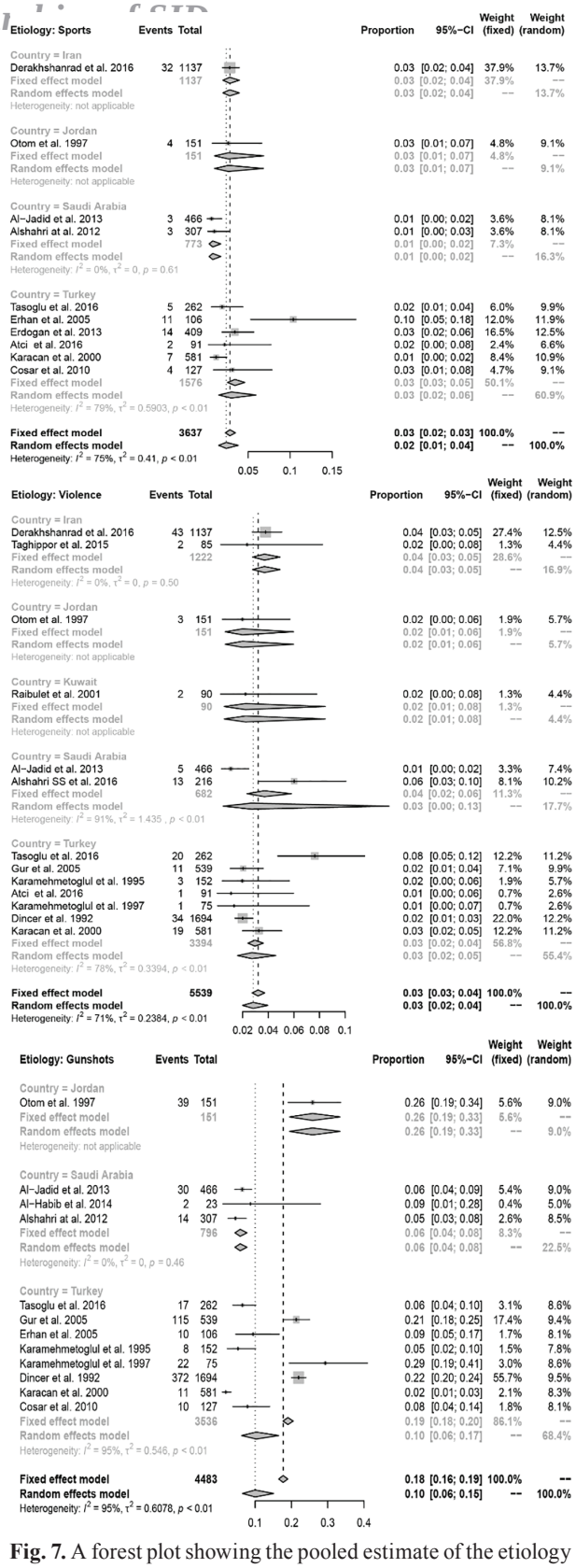

Fig. 7. A forest plot showing the pooled estimate of the etiology of injury (continued)

Quality of the Included Studies

Sixteen studies were of good quality; six studies have score of 3, and ten studies have a score of 4. The remaining thirteen studies were of poor quality; having score ≤2. Most studies achieved low score in both the clear definition of inclusion and exclusion criteria and the qualifications of the person responsible for data collection. Also, many studies received low score in the category of security of the data repositories. Many studies either did not mention the form of the data source or did not mention the appropriateness of these data repositories.

Discussion

Spinal cord injury (SCI) negatively affect the patient's physical, social and psychological well-beings. Besides its paramount economic costs, SCI places profound burden on healthcare systems. In addition to the importance of epidemiological evidence to help in implementing effective prevention strategies, it will help physicians in managing cases with SCI. Because of lack of resources and limited number of rehabilitation centers across the MENA region, this knowledge is crucial [43, 44].

Based on this comprehensive meta-analysis, the annual incidence of SCI in the MENA region was found to be 23.24/million. 77% of SCI cases were estimated to be males. Mean age of all cases was estimated to be 31.32. The most affected age group was those aging 20-29 then those aging 30-39. Thoracic spinal region was the most affected. Complete paraplegia was the most common type of injury. Furthermore, MVA and falls were the leading causes of SCI. However, it is difficult to compares countries upon causes of SCI because of lack of standardization in defining the etiology of SCI. For example, different studies have different definition of MVA. Some studies consider hitting pedestrians as MVA whereas other studies considered them as different category. The same issue was found in defining sports, whether it include diving.

In addition, there is lack of evidence about SCI in most countries. Only seven countries out of the twenty-one MENA countries have published reports about the epidemiology of SCI. This may restrict the generalizability of this meta-analysis results across the region.

Also, most studies used a retrospective chart review of their records. In most studies, it is unclear whether the records came from a register or paper records.

Finally, this review, up to our knowledge, is the most comprehensive systematic review of published studies about the epidemiological patterns of SCI in the Middle-East and North-Africa region.

Conclusion

This review summarized evidence pertaining to the pattern of traumatic spinal cord injuries in the MENA region. It will help in implementing preventive measures and will help in managing patients with SCI. It will help healthcare systems

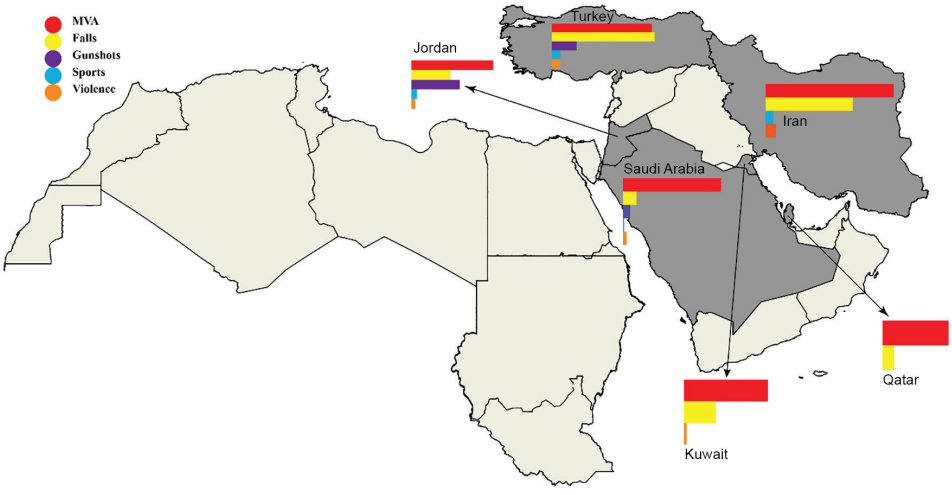

Fig. 8. Etiology of the spinal cord injury by country.

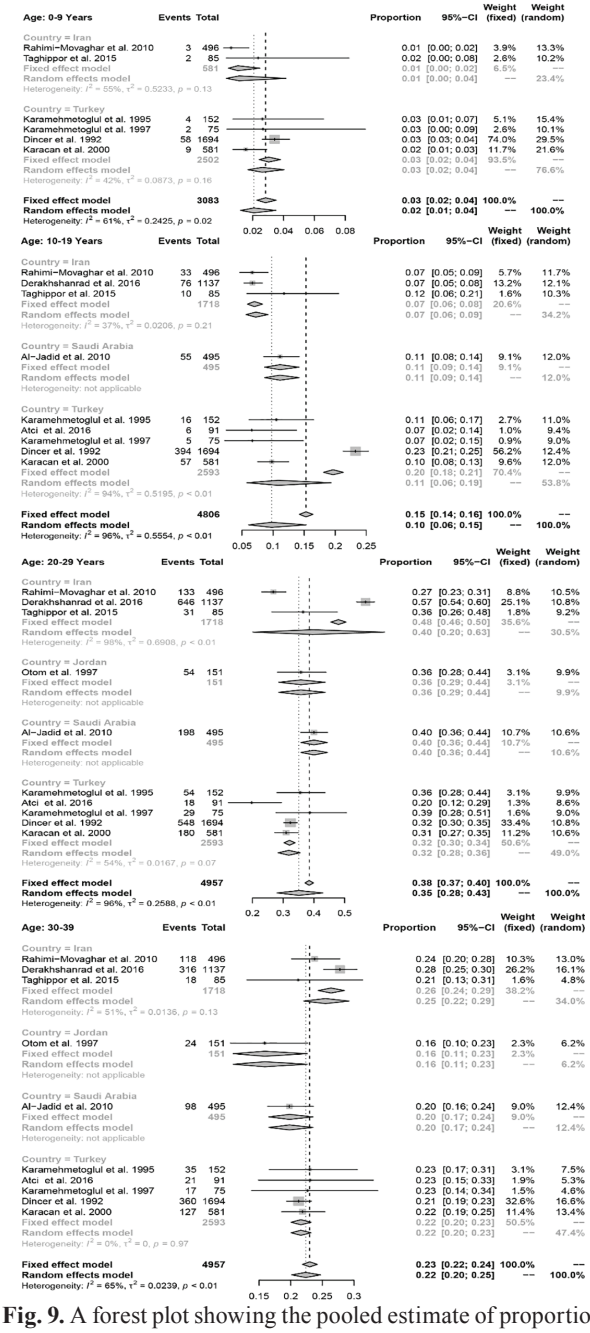

Fig. 9. A forest plot showing the pooled estimate of proportion of SCI cases by the age group.

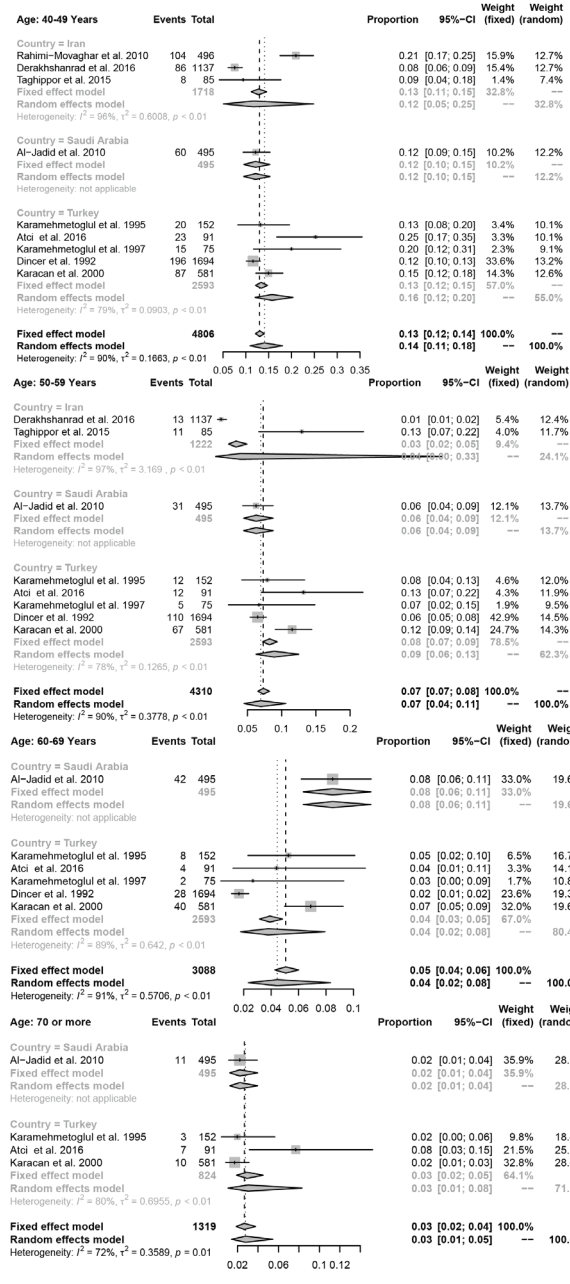

Fig. 9. A forest plot showing the pooled estimate of proportion of SCI cases by the age group. (continued)

in the MENA region in properly allocating resources to improve the care of patients with SCI.

Limitation

Lack of full data reporting and the limited number of available articles restrict the generalizability of the analysis results. Also, there is discrepancy in defining etiology of SCI. So, the data of this meta-analysis should be interpreted carefully.

Recommendations

More studies in this field, especially from countries not included in this review, are needed. Large scale national studies are encouraged to ensure representativeness of the sample. Moreover, using more standardized definitions in reporting SCI epidemiological studies will help to solve discrepancy in the literature [45, 46].

Conflicts of Interest: None declared.

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